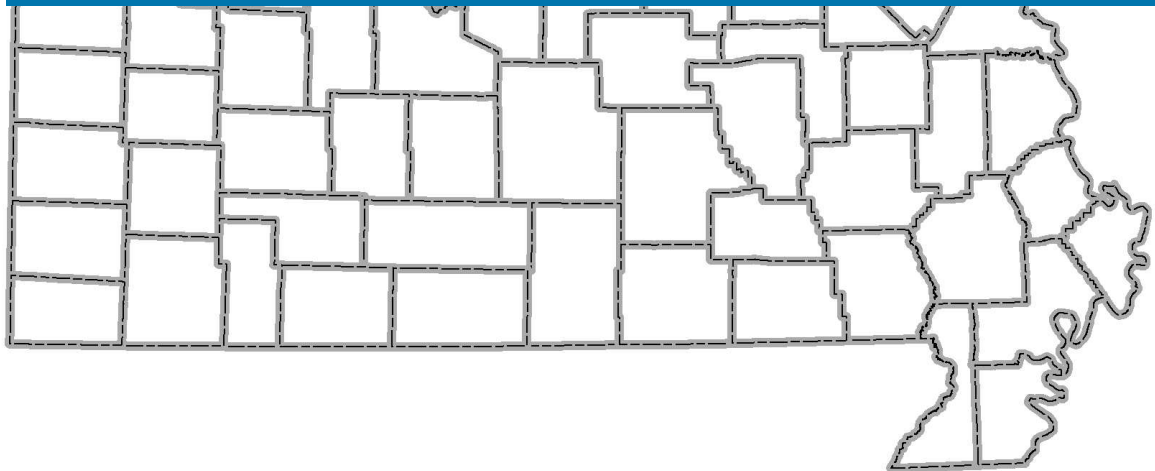


The State of *Our Missouri Waters*

Salt River Watershed



The Missouri Department of Natural Resources seeks to improve the availability of water resource information to communities where impact to these water resources is felt most.

The information presented in this summary is intended to increase awareness of how activities on land and in water have an influence on water resource quality and quantity. The department greatly values local input and engagement regarding the mission of ensuring safe and ample water resources, and will continue to seek local guidance to further focus department efforts and funding strategies for the betterment of *Our Missouri Waters*.

Salt River Watershed

The State of Our Missouri Waters

Importance of Water Quantity and Quality

Water shortages can have severe and expensive consequences. Adequate water supplies are vital not only to human health and safety, but also to the prosperity of our state. Whether it is for crop irrigation, industrial manufacturing or power generation, water is at the core of human existence and sustainability. A few decades ago, the supply of water in Missouri was considered virtually unlimited. As population and industry have increased, a need for statewide water planning has emerged.

Water quality impairments can also have severe impacts on human health and the environment and be extremely expensive. Unfortunately and more importantly, many water quality impairments are only discovered once the consequences of poor water quality have been realized. For this reason, it is important that locals are involved in the protection of their water quality and quantity so as to prevent irreversible consequences.

Key Points

The Salt River HUC 8 watershed composes 26% of the Salt River Basin in northeast Missouri. Sub-watersheds Lick, Sandy, Indian and Little Indian creeks and Shell Branch drain into Mark Twain Lake in Monroe and Ralls counties. Mark Twain Lake was created when construction of the Clarence Cannon Dam was completed in 1984. Mark Twain Lake provides for multiple uses, including hydroelectric power, flood control, recreation, fish and wildlife conservation, water supply and control of water levels for navigation downstream on the Mississippi River. At normal pool, the lake provides 18,600 acres of surface water and 285 miles of shoreline. The dam is capable of producing up to 58,000 kilowatts of power. A re-regulation dam is located 9.5 miles downstream from Clarence Cannon Dam. Clarence Cannon Dam is located about 63 miles upstream from the Salt River's confluence with the Mississippi River. The Salt River meets the Mississippi River just north of Louisiana, Missouri at River Mile 284. There are abundant recreational opportunities in the Salt River Watershed, including public areas at Mark Twain Lake and near the Mississippi River. Canoeing opportunities are available on the Salt River downstream of the re-regulation dam downstream of Mark Twain Lake.

Clarence Cannon Wholesale Water Commission (CCWWC), which treats water from the North Fork Salt River Arm of Mark Twain Lake, provides treated drinking water to ten of the 13 community public water systems in this watershed, either as their sole source or partial source of water. Several communities, including Monroe City, Vandalia, and Bowling Green, have their own treatment plants that treat water from local city lakes, while Laddonia is the only community public water system that treats groundwater from local wells.

Land use within the watershed is dominated by cropland, but grassland and forested land are also prevalent. Low permeability of glacial till restricts movement of water to the subsurface, which can cause stream flows to increase rapidly even in small precipitation events. Population within the watershed increased by approximately 8.0 % between the 2000 and 2010 census, and is expected to continue to have a slight increase in the next 15 years, which will likely lead to an increase in developed areas.

Opportunities

Community Involvement

- Through education, advocacy and hands-on projects, communities, groups and individuals can be involved in and promote watershed improvement activities. Some examples include, watershed education for schools, litter control, tree planting, water quality monitoring and storm drain stenciling.

Education and Outreach

- Technical assistance providers are available for training and assistance regarding several topics such as source water protection, municipal drinking water loss, water main leak detection, asset management, water conservation planning and implementation, and I/I (inflow and infiltration) reduction.
- Training is also available to livestock operations and landowners regarding the benefits of alternate watering sources for livestock, improvements to land application practices, best management practices and associated cost-share programs.

Financial Assistance

- **Clean Water and Drinking Water State Revolving Funds** are available to build or improve municipal wastewater and drinking water infrastructure and support agricultural and urban projects such as improvements to urban runoff, wet weather flow, stormwater and sewer overflow issues, water reuse and conservation and alternative treatment projects.
- **319 Nonpoint Source Funds** are available to assist organizations with implementation of on-the-ground practices that control, reduce or manage nonpoint source pollution such as riparian buffer strips, detention ponds, limitation of animal waste to stream and sinkholes.
- **Source Water Protection Grants** and **Well Plugging Grants** are available to public water systems to support safe well abandonment procedures and source water protection implementation and planning efforts.
- A full list of department funding sources is available at <http://dnr.mo.gov/financial.htm>

Salt River Watershed

The State of Our Missouri Waters – Current Conditions and Trends

What is a Watershed?

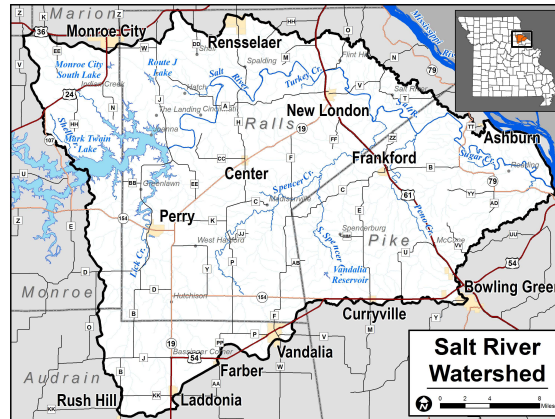
A watershed is an area of land defined by ridges, from which waters flow into a particular lake, river or wetland.

Salt River Basin Characteristics

- Drainage area of 794 mi²
- Includes portions of six counties
- Part of the Salt River system
- Largest city population located in Bowling Green, Vandalia, Monroe City, New London, Perry and Ladonia.
- Est. pop. In the watershed was 17,086 people in 2000 and 18,451 people in 2010. Est. for 2000 to 2030 predict Monroe, Audrain, Ralls and Pike counties will increase in population ranging from 2.1 to 7.0 percent.

Recreational Resources

Mark Twain Lake provides 18,600 acres of water for boating, swimming and fishing. There are several U.S. Army Corps of Engineers recreation areas and Mark Twain State Park that offer fishing and waterfowl viewing and several Department of Conservation areas that also offer hunting. Canoeing opportunities are available on the Salt River downstream.



Water Resources

Surface Water

There are three lakes ranging in size from 92 acres to 16,620 acres, totaling 16,827 lake acres. There are 1,300 miles of major streams. Some of the larger streams are Lick, Indian, Turkey, Sugar, Spencer, Peno and Grassy creeks and Salt River. Surface water sources, including South Lake and Route J Lake in Monroe City and Vandalia Lake, provide public water supply. Surface water sources outside the watershed including the North Fork Salt River arm of Mark Twain Lake, Bowling Green Lake #1 and Lake #2, and the Mississippi River at Louisiana and Hannibal also provide drinking water.

Groundwater

Mississippian-, Ordovician-, and Cambrian-age strata can supply from 10 to more than 1,000 gallons per minute of potable water, depending on depth. Modest quantities of marginally potable groundwater are locally available in some of the shallow Mississippian strata where it is not overlain by Pennsylvanian strata. The Pennsylvanian strata have an overall low permeability and generally yield small quantities of marginal to poor quality water. There are an estimated 178 private domestic wells that provide an estimated 53,200 gallons of water annually for domestic uses.

Springs

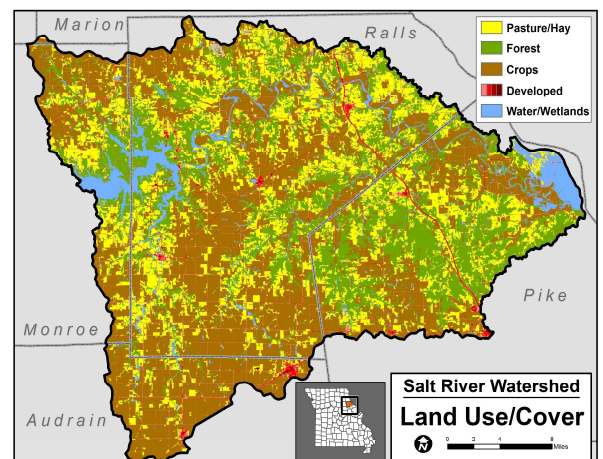
There are 21 mapped springs located in the watershed, but none of the springs are named. Thirteen springs are located in Ralls County and eight springs are located in Pike County.

Geology/Hydrology

The surface of the basin is glacial till (generally less than 50 feet in depth) overlain by a 4 to 8 foot layer of loess. The till is predominantly clay, with some rock and gravel intermixed with occasional sand lenses. In the upper part of the basin, glacial deposits overlie limestones and thick shale units of Mississippian age. In the lower part of the basin, the till is underlain by limestones and with thick shales of Ordovician age (Koenig 1961). Low permeability Pennsylvanian-age bedrock units underlie the western portion of the basin, but in the eastern portion of the basin the uppermost bedrock contains permeable carbonate bedrock. There are no sizeable springs, indicating that the overlying till restricts movement of water to the subsurface. Two hundred and seventy sinkholes have been identified in the basin, primarily on the eastern side of the basin where groundwater contamination can readily discharge from shallow springs. There are isolated occurrences of upwelling of saline groundwater from Ordovician sandstone. Twenty-eight percent of streams evaluated for discharge within the watershed have been determined to be losing streams. Nearly all water movement is through the surface stream network, and base flow is not well sustained in dry periods.

Land Use

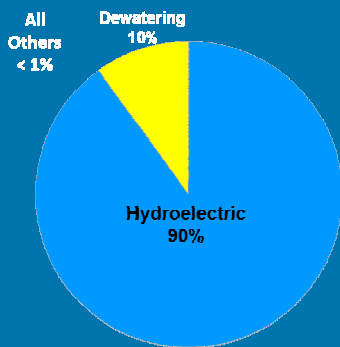
Land use is approximately 42 percent cropland, 25 percent forest, 22 percent grassland, 5 percent developed, 3 percent wetland, and 3 percent water. The majority of the watershed has soil types with slow to very slow infiltration rates. Expected population growth in the watershed may lead to greater percentage of developed area.



Salt River Watershed

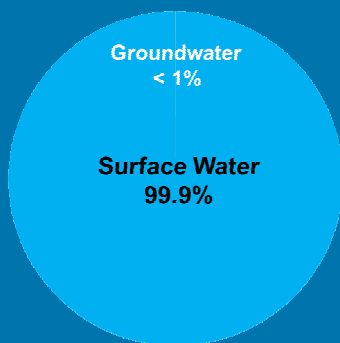
The State of Our Missouri Waters – Current Conditions and Trends

Estimated Annual Major Water Use by Category (2013)



Most water used in the watershed is surface water for hydroelectric power generation at Clarence Cannon Dam. Drinking water supply sources in the watershed include South Lake and Route J Lake in Monroe City and Vandalia Lake.

Estimated Annual Major Water Use by Source

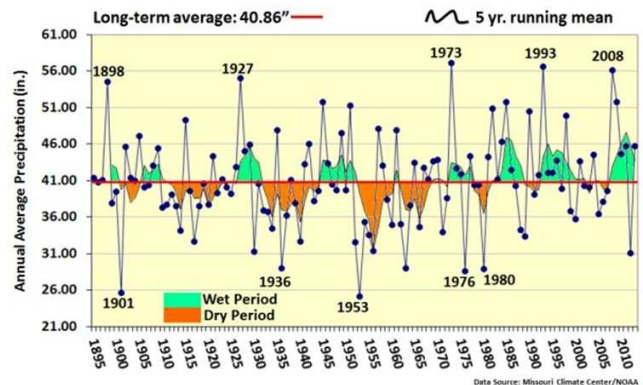


Climate and Water Availability

Precipitation

Annual precipitation totals reveals several wet periods have dominated since the early 1980s. This wet pattern has also been accompanied by an increasing trend of heavy precipitation events. Severe drought occurred during 2012, but this drought was brief compared to major multi-year droughts that occurred in the 1930s and 1950s. Tree ring analyses conducted in Missouri and historic observation data show periods of multi-year severe droughts in Missouri's history, indicating that extended dry periods are likely to occur in the future.

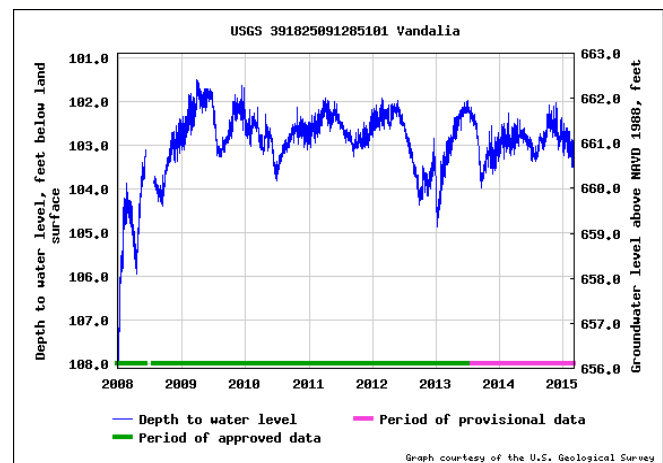
Missouri Annual Average Precipitation (1895-2013)



Groundwater and Stream Monitoring

There is one groundwater monitoring well within the watershed as part of the Missouri Observation Well Network. The hydrograph, right, represents water levels at the Vandalia monitoring well. This graph highlights how short periods of drought, such as the 2012 drought, can cause groundwater levels to quickly change. There are currently five stream gauges that measure average stream flow that varies from 20 to 850 million gallons per day.

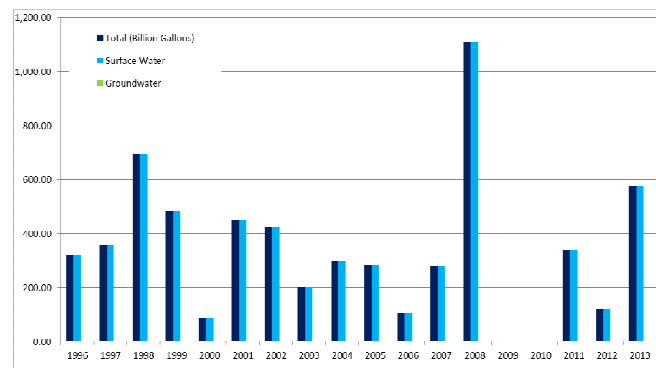
USGS Vandalia, MO Groundwater Monitoring Point



Major Water Use Characteristics

Eight registered major water users, with at least a 100,000 gallons (70 gal per minute) per day withdrawal or diversion capacity, are present in the basin. The estimated annual water use of these major water users is 573 billion gallons, of which 99.9 percent is surface water used for hydroelectric power generation. There are 13 community public water systems. One of these systems, Laddonia, treats groundwater from local wells. Clarence Cannon Wholesale Water Commission treats water from the North Fork Salt River Arm of Mark Twain Lake and provides treated drinking water to 10 community public water systems, either as a sole source or partial source to those public water systems. Monroe City, Vandalia and Bowling Green have their own treatment plants treating water from local city lakes and two public water districts purchase treated water from the Mississippi River at Louisiana and Hannibal. Groundwater and surface sources currently provide about 0.56 million gallons of water a day to 10,108 people, and these sources have a total capacity of 2.30 million gallons per day.

Historical Water Use - Salt River Watershed



Salt River Watershed

The State of Our Missouri Waters—Current Conditions and Trends

Protection of Our Natural Resources

The department exercises authority under Missouri's Clean Water Law to regulate point sources of pollution. When point sources are known or discovered, the department issues permits for these sources to limit the amount of certain water contaminants that may be discharged into the water body.

The department also has resources to help people proactively plan to protect water resources, such as:

- Source Water Protection Plans for drinking water sources
- Section 319 funding for watershed planning and projects
- Funding to plan for source water protection
- Soil and Water Conservation funding
- State Revolving Fund grants and loans for community drinking water and wastewater improvements

A full list of department funding sources is available at dnr.mo.gov/financial.htm

It is important to note that resources are limited and local involvement, in determining most critical and effective focus areas, is invaluable.

Watershed Protection

Water Quality Impairments

Section 303(d) of the federal Clean Water Act requires each state identify waters that do not meet water quality standards and for which adequate water pollution controls are not in place. These identified waters are considered impaired. Water quality standards protect beneficial uses of water such as whole body contact (e.g. swimming), maintaining fish and other aquatic life, and providing drinking water for people, livestock and wildlife.

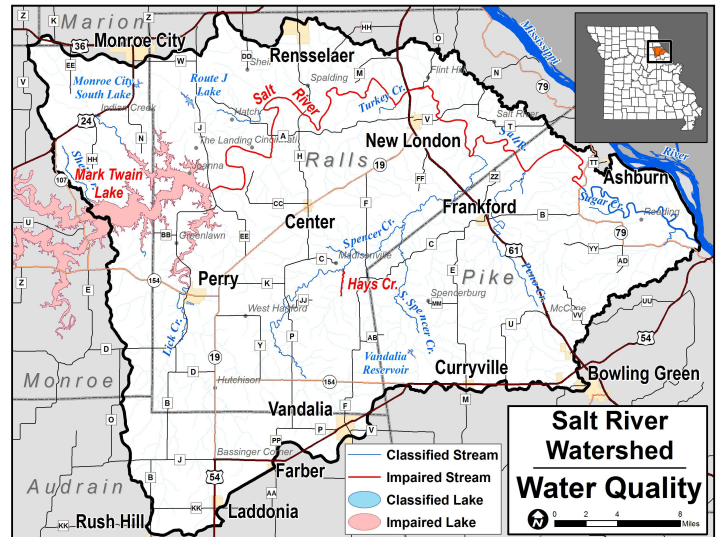
The following lakes and streams are listed on the State's 2014 list of impaired waterways and are presented on the adjacent map: Mark

Twain Lake (for mercury in fish tissue), Monroe City Lake (Route J lake, for mercury in fish tissue), Salt River (for mercury in fish tissue and low dissolved oxygen). The source of mercury in fish tissue is atmospheric deposition of mercury. For lakes and streams impaired for having mercury in fish tissue, the fish in these water bodies are safe to consume in moderate amounts and people eating fish caught from these waters should follow the statewide advisory for fish consumption provided by the Missouri Department of Health and Senior Services at <http://health.mo.gov/living/environment/fishadvisory/pdf/fishadvisorysummary.pdf>.

Impairments can be caused by known sources like point or nonpoint source pollution, or may be unknown; however, identifying activities near impaired water bodies can provide key information in determining the sources of contamination as well as developing solutions for impaired waters.

Examples of **point sources** of pollution include municipal wastewater treatment plants, land disturbance sites, large confined animal operations, and treated industrial wastewater discharges. Common challenges for wastewater treatment include the limited contaminant removal capacity of certain types of treatment. When facilities experiences difficulty in providing the proper level of treatment and contaminant removal, the department often works with them to improve the treatment process and quality of the discharge. In the case that point source emitters are unwilling to improve the quality of their discharge, the department has regulatory authority to ensure that inappropriate discharges are discontinued in a timely manner.

Nonpoint pollution sources refer to contaminants that do not come from specific conveyances and may come from multiple sources, such as failing septic systems and contaminants carried in stormwater runoff from rural, urban, and agriculture lands. Other causes of water body impairments include natural causes like precipitation, climate, and drought which can alter stream flow and channel characteristics leading to changes in water quality.



Salt River Watershed

The State of Our Missouri Waters—Current Conditions and Trends

General Water Quality Criteria

A water body is considered impaired if it does not meet water quality standards that specifically protect its beneficial uses, such as drinking water, recreational uses and fish or other aquatic life health.

Missouri's Process to Improve Water Quality

Monitoring – Lakes and Streams



Assessment of Data



Identification of Impaired Waters



Corrective Plans (TMDLs) –
MDNR Developed/
EPA Approved

NPDES:

National Pollutant Discharge Elimination System. In Missouri, NPDES permits are also known as Missouri State Operating (MSOP) permits.



Watershed Protection

Total Maximum Daily Loads (TMDL)

A TMDL is the mathematical calculation of the amount of a specific pollutant that a water body can absorb and still meet water quality standards. A TMDL study identifies the potential or suspected pollutant sources in the water and allocates the allowable pollutant load among these sources. It also includes an implementation plan to identify how the load will be reduced to a level that will protect water quality. There are no completed TMDLs in the Salt River Watershed.

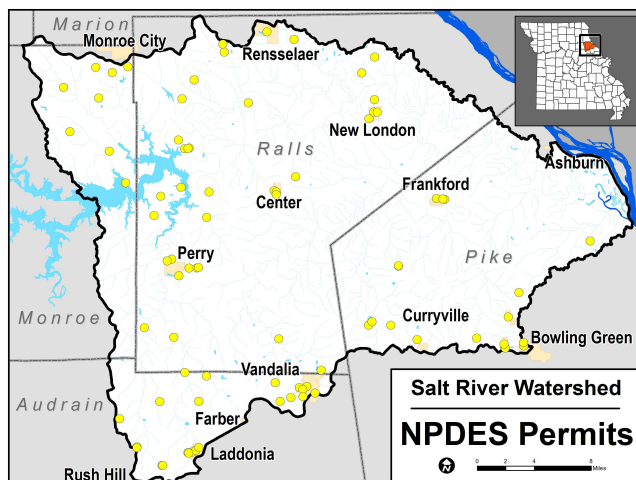
Water quality impairments include mercury in fish tissue at Mark Twain Lake and Monroe City Lake (Route J Lake) and low dissolved oxygen in the Salt River downstream of Clarence Cannon Dam and the re-regulation dam. Mercury in fish tissue is associated with elevated levels of mercury in the lakes where the fish are sampled, and is understood to come largely from atmospheric deposition. Human activities, including burning of coal and waste, and other industrial operations, along with natural geologic sources including volcanoes contribute to mercury in the atmosphere. Atmospheric mercury is widely disseminated and can circulate for years before being deposited on the land and in surface waters. Low dissolved oxygen levels can occur in tail waters below dams when water from the lower depths of the lake is released from the dam. Water quality monitoring is conducted downstream of Clarence Cannon Dam and upstream of the re-regulation dam to try to understand and manage dissolved oxygen levels in water downstream from the lake.

For more information regarding TMDLs, including the TMDL development schedule, please visit the link provided: <http://dnr.mo.gov/env/wpp/tmdl/index.html>

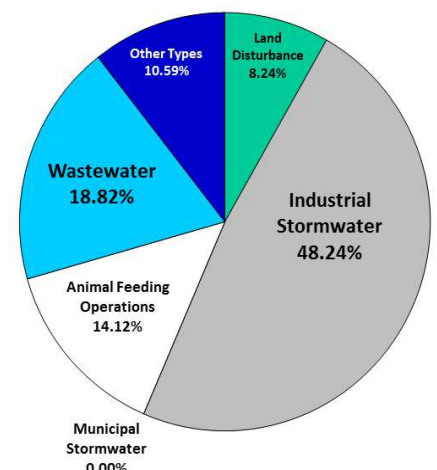
Regulated Point Sources

The department regulates point sources by issuing permits that prescribe conditions of operating the point discharge and limit the discharge of water contaminants. In addition, the department inspects regulated facilities and analyzes water samples to ensure the facilities are not polluting waters. It's also important that communities look to the future for watershed planning in order to maintain awareness of wastewater treatment types, their impacts and upcoming regulations.

The following graphics illustrate the type and distribution of permitted sites in the Salt River Watershed.



Distribution of Permit Types



Salt River Watershed

The State of Our Missouri Waters—Current Conditions and Trends

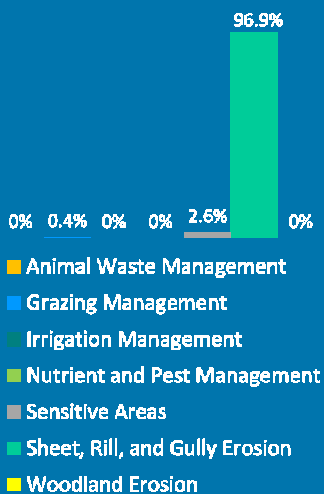
Local Watershed Improvements

Local Awareness

Is it safe to fish or swim in the nearby stream? Does the stream provide habitat suitable for fish? What does it cost to make this water potable? Will I have enough water during a drought?

Impacts to water quality and quantity are most critical to local communities; however, impacts are often not realized until a dire situation arises as a result of poor water quality or quantity. Local awareness and involvement can lead to pollution prevention and reduction, water supply sustainability and can give communities the upper hand in protecting, preserving and enhancing local water supplies for generations to come.

Conservation Practices



Missouri Stream Team and Volunteer Water Quality Monitoring

Missouri Stream Teams strive to gain and share knowledge regarding the state's stream systems and the problems and opportunities they face. The Missouri Stream Team Program is a partnership between the departments of Natural Resources and Conservation as well as the Conservation Federation of Missouri and the citizens of Missouri. Besides improving stream conditions, Stream Teams often provide useful data in targeting areas that should be monitored more closely for impairments. The Missouri Stream Team Watershed Coalition has compiled and reported monitoring data which demonstrates the importance of watershed protection, preservation and enhancement by local communities. (image from <http://mstwc.org/who-we-are/vision-mission-goals/>)

The Volunteer Water Quality Monitoring Program is one of the most popular activities of the Missouri Stream Team Program. Stream Team volunteer monitors have provided the department with valuable water quality data from one site throughout the watershed.



Soil and Water Conservation and Nonpoint Source Grants (319 Grants)

Watershed project grants are provided by DNR to local communities to conduct outreach, implement and measure effectiveness of conservation practices, and conduct watershed planning. In the Salt River watershed, one of these grants has been awarded in the watershed in the last ten years. A 319 grant was awarded to the Monroe County Soil and Water Conservation District to help host the "It's the Water" workshop at the Soil and Water Conservation Society-West North Central Regional Conference. The workshop presented a holistic picture of Upper Mississippi River water-quality issues and showcased educational and technical strategies related to watershed management.

Source Water Protection Projects and Grants

This voluntary program is designed to assist public water systems and the communities they serve with developing local voluntary source water protection plans to protect their source of drinking water from existing or additional contamination sources. Participating public water systems include: Monroe City, Vandalia, Bowling Green, and Clarence Cannon Wholesale Water Commission (CCWWC). CCWWC has an active source water protection plan for its intake on the North Fork Salt River Arm of Mark Twain Lake and Monroe City, Vandalia, and Bowling Green have had source water protection plans for their city lakes. More information on the Source Water Protection Program and grants can be found on our website: <http://dnr.mo.gov/env/wpp/pdwb/swpp.htm>.

Well Plugging Grants

As part of Source Water Protection, the department offers grants to plug abandoned wells. Inactive wells can act as a direct conduit for pollutants to enter our water sources. Safely closing these wells is another layer of protection for pollution prevention.

Soil and Water Conservation Cost Share Programs

Soil and Water Conservation Districts set goals for conservation issue concerns. These practices are funded and implemented to help districts meet their resource conservation goals, which conserves soil and improves water quality by reducing sedimentation in our rivers and streams. The chart on the left illustrates the number of practices implemented for each concern in the watershed from 2009 to 2014, relative to the total number of practices for this watershed. No irrigation management practices were implemented during this time. District funding requests for FY15 show that grazing management and sheet, rill and gully practices are most prevalent.

Salt River Watershed

The State of Our Missouri Waters

Contact Information for this Watershed

Missouri Department
of Natural Resources
Northeast Region
Watershed Coordinator
Mary Culler
1709 Prospect Drive
Macon, MO 63552
660-385-8000

Or visit the Web at
dnr.mo.gov/omw

Resources

Education and Outreach Resources include:

Missouri Department of Natural Resources' Our Missouri Waters dnr.mo.gov/omw

Missouri Department of Natural Resources Financial Assistance Opportunities
<http://dnr.mo.gov/pubs/financial-asst-brochure-2014.pdf>

Natural Resources Conservation Service (NRCS) <http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/technical/>

Missouri Rural Water Association (MRWA) <http://www.moruralwater.org/training.php>;
<http://www.moruralwater.org/tools.php>; <http://www.moruralwater.org/dlcenter/>

Missouri Public Utilities Alliance (MPUA) <http://www.mpu.org/Training.php>; http://www.mpu.org/Untitled_Page_4.php

EPA Region 7 Environmental Finance Center (EFC) http://webs.wichita.edu/?u=HUGOWALL&p=/Centers_Research/Environmental_Finance_Center/

Funding Resources include:

Natural Resources Conservation Service (NRCS) <http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/>

United States Department of Agriculture Rural Development (USDA-RD) <http://www.rurdev.usda.gov/ProgramsAndOpportunities.html>

Missouri Department of Economic Development (DED) <http://www.ded.mo.gov/BCS%20Programs/BCSProgramDetails.aspx?BCSProgramID=10>; <http://www.ded.mo.gov/Community/InfrastructureAssistance.aspx>

References

2010 Census data (<http://www.census.gov/>)

Center for Applied Research and Environmental Systems (<http://www.cares.missouri.edu/>)

Department of Natural Resources' Groundwater Level Observation Well Network Page (<http://dnr.mo.gov/env/wrc/groundwater/gwnetwork.htm>)

Department of Natural Resources' Missouri State Water Plan Series, Surface Water Resources of Missouri, 1995, Groundwater Resources of Missouri, 1996. (<http://dnr.mo.gov/env/wrc/statewaterplanMain.htm>)

Department of Natural Resources' Source Water Protection Program Page (<http://dnr.mo.gov/env/wpp/pdwb/swpp.htm>)

Department of Natural Resources' Major Water Users Page (<http://dnr.mo.gov/env/wrc/mwu-forms.htm>)

Missouri Stream Team Program Website, (<http://www.mostreamteam.org/aboutTeams.asp>)

Missouri Stream Team Watershed Coalition Website, (<http://mstwc.org/>)

Multi-Resolution Land Characteristics Consortium, 2011 and 2001 National Land Cover Database, (<http://www.mrlc.gov>)

Missouri Climate Center, (<http://climate.missouri.edu/modata.php>)

U.S. Army Corps of Engineers, Southwest Missouri Water Resource Study—Phase I. Sept. 2012 (http://tristatewater.org/?page_id=12)

Guinan, Pat, State Climatologist, MU Extension, Missouri Climate Center, (<http://climate.missouri.edu/modata.php>)

